C51A-0951
AGU 2017

ArcticDEM Validation & Accuracy Assessment

Salvatore G. Candela [1](Candela.13@osu.edu), Ian Howat[1], Paul Morin[2], Myoung-Jong Noh[1], Claire Porter[2]

[1]School of Earth Sciences and Byrd Polar Research Center, Ohio State University, Columbus, Ohio, USA
[2]Polar Geospatial Center, University of Minnesota, Minneapolis, Minnesota, USA

The Ohio State University
BYRD POLAR AND CLIMATE RESEARCH CENTER

The ArcticDEM Project

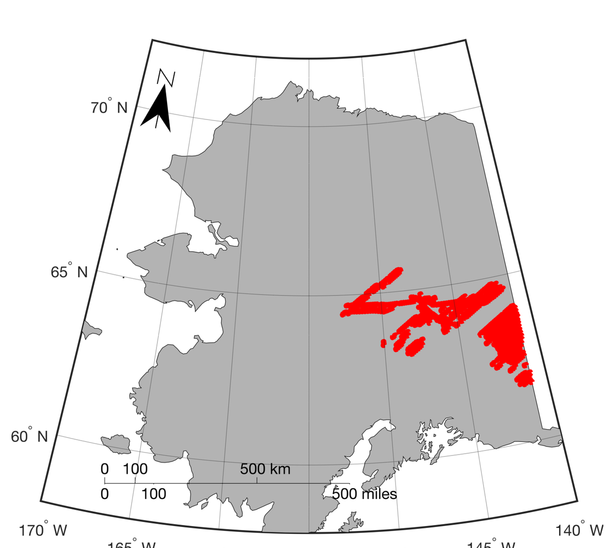
What is ArcticDEM?

The topography of the Arctic was among the most poorly mapped on Earth. Yet, the terrain of the Arctic is undergoing rapid changes making such data critical for both scientific investigations and infrastructure planning. **The objective of ArcticDEM is to produce and openly distribute high resolution (2-5 m) Digital Surface Models (DSMs) of the entire Arctic landmass**, including all areas above 60 degrees N, and all of Alaska, Greenland and the Kamchatka Peninsula.

How accurate is it?

While the DSMs have an internal (pixel-to-pixel) accuracy of 0.2 m (Noh and Howat, 2015), the initial geolocation may have systematic offsets of 3-5 m in the vertical and horizontal resulting from sensor model errors. Both the strips and mosaics are registered to seasonally-subsetted and quality controlled ICESat-1 elevations due its density of coverage at high latitudes and high report accuracy (~10cm). ICESat, however, has a relatively coarse measurement footprint (~70 m) which may impact the precision of the registration. Further, the ICESat data predates the ArcticDEM imagery by a decade, so that temporal changes in the surface may also impact the registration. Finally, biases may exist between different the different sensors in the ArcticDEM constellation. **Our objective is to use high-accuracy airborne LiDAR surveys conducted close in time to DSM acquisition to constrain the vertical accuracy of ArcticDEM strips over a range of terrains.**

DSM & LiDAR data

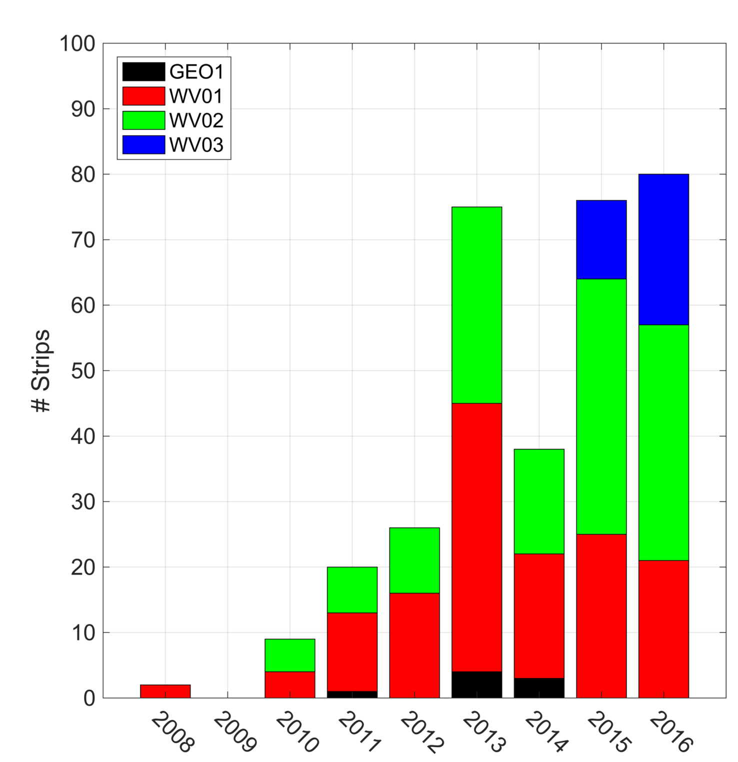


NASA G-LiHT LiDAR Level-3 data is distributed as an LAS format x,y,z point cloud in UTM WGS84 projection, with heights above EGM96.

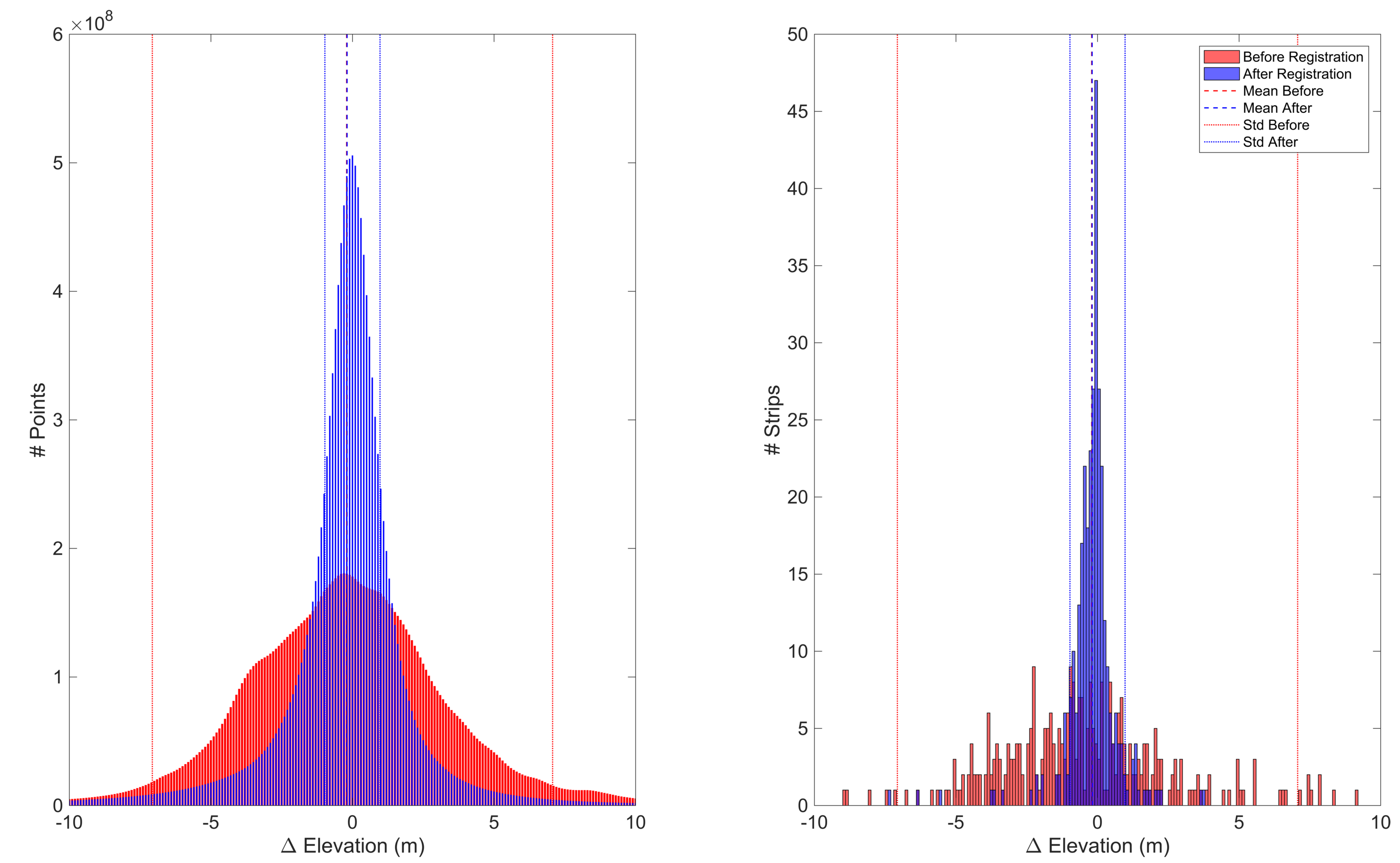
- 14,049,123,904 points collected between July 2014 and August 2014
- 63,726 km² of coverage
- 21,552 km of flight line

ArcticDEM strips are provided at 2-m spatial resolution in 32-bit GeoTIFF format, in a polar stereographic projection (EPSG:3413), with elevation in reference to WGS84

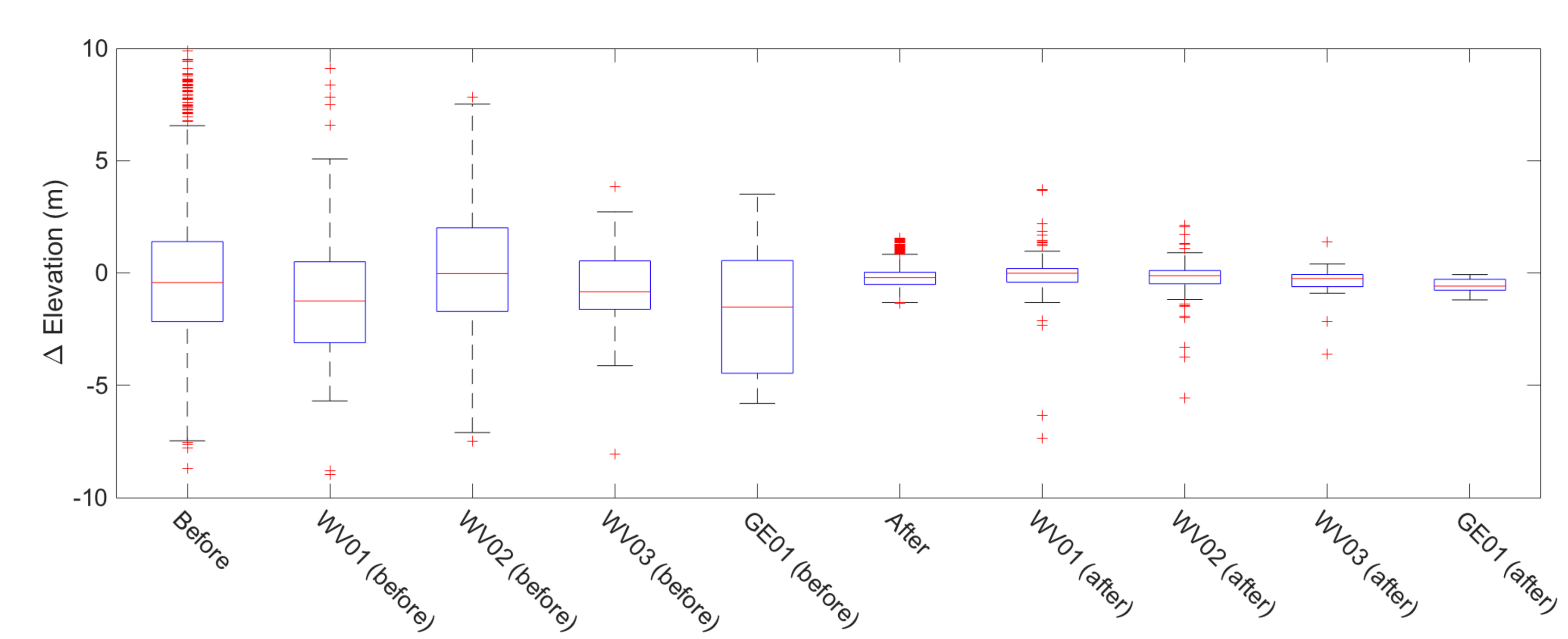
- 326 DSM's from 2008 and 2016
- ~609,620 km² of coverage



Residual Bias in Elevation Before and After Correction

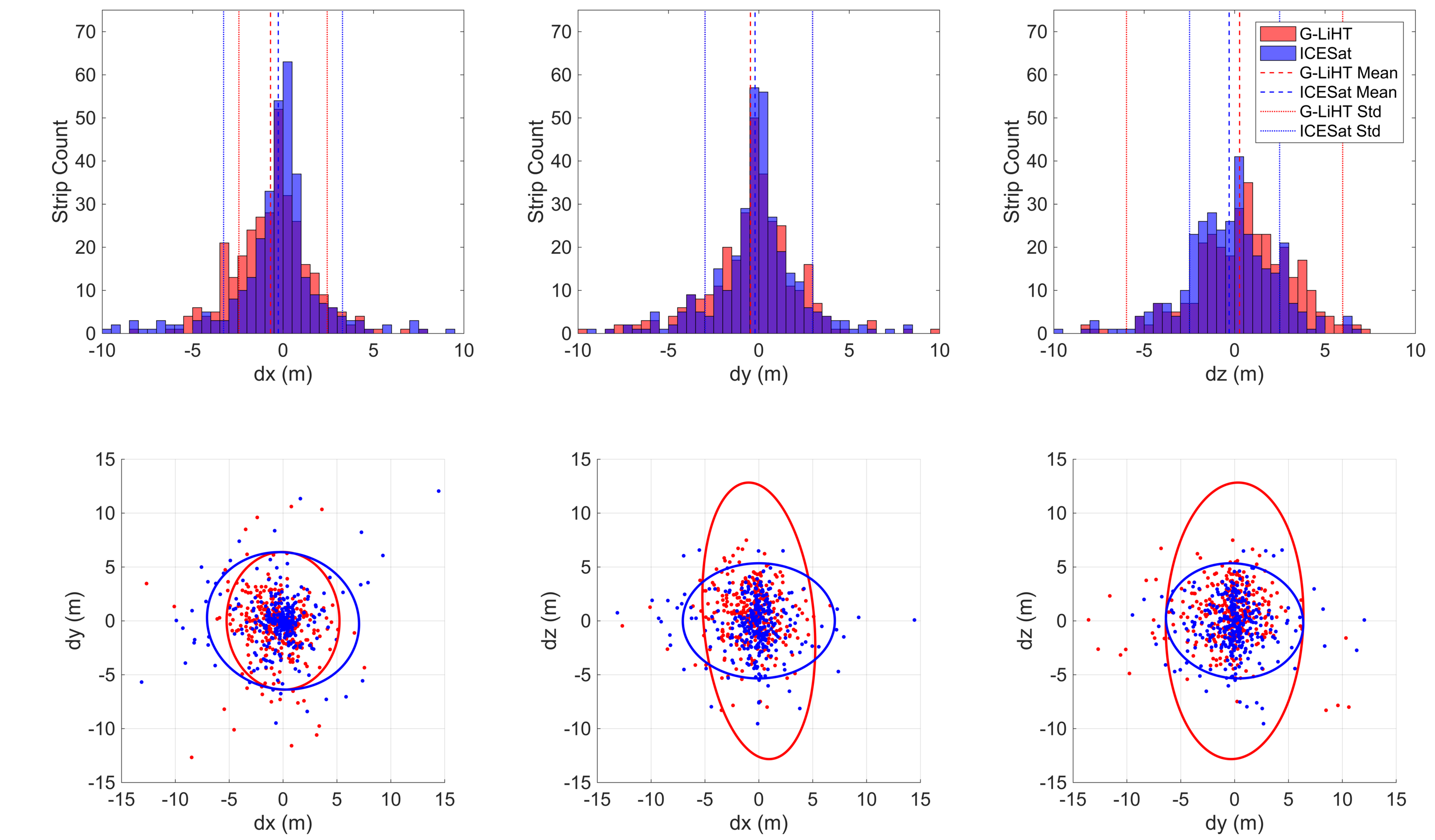


The left panel shows error between each set of point clouds, while the right panel shows mean error for each strip. The mean and standard deviation of the elevation differences before bias removal is -0.20 m ±7.07 m, and is -0.19 m ±0.97 m after bias removal though coregistration. (Right panel)

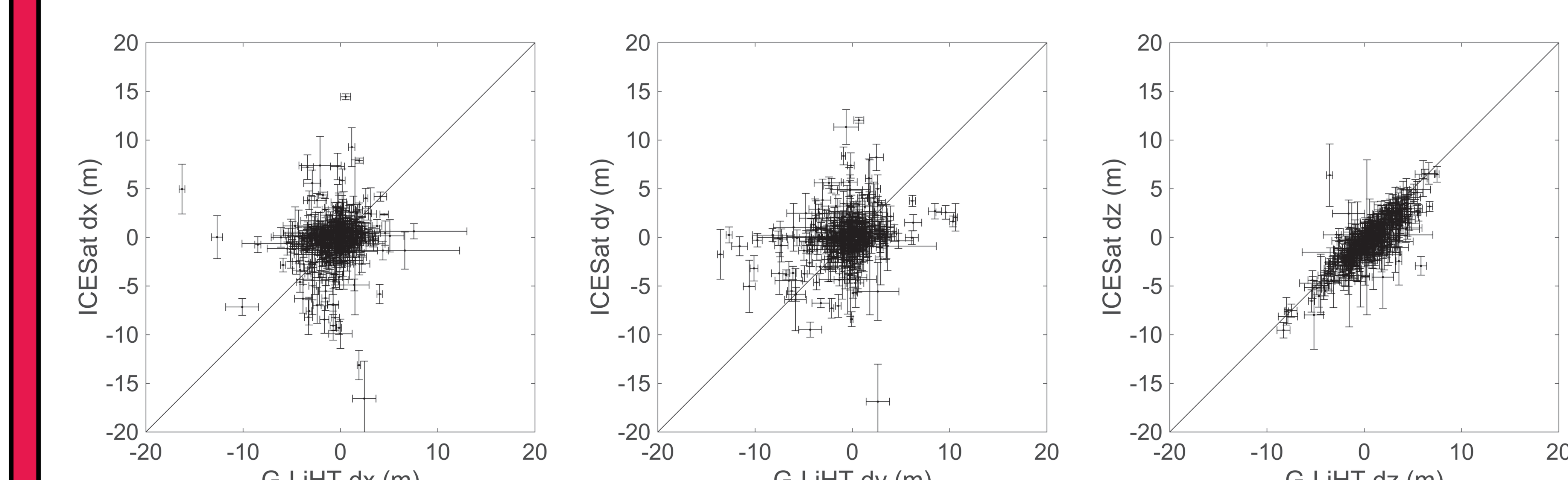


We can see a fairly large degree of variability before bias removal, but the post bias removal results show there is little variation between the four sensor models utilized by ArcticDEM, and any bias apparent in the original data is effectively removed.

How does ICESat derived correction compare to G-LiHT?



Top are histograms of offsets for strips in the x, y and z directions and bottom are scatter plots of offsets between each direction component. Bias corrections derived independently from ICESat and G-LiHT are compared. With respect to dx, dy, and dz, no significant difference was found. Likewise, correction parameters were correlated with each other, to check for any systematic bias. Error ellipses represent 90% confidence interval. With respect to all combinations of dx, dy and dz for both G-LiHT and ICESat correction parameters, no significant correlation was found.



Plots of translational offsets in x, y and z between each test ArcticDEM strip. On the x axis, G-LiHT airborne LiDAR and, on the y axis, ICESat-1. Error bars in both axis are ± 70th percentile. Correction parameters were also compared pairwise to look for any difference in pairs of correction parameters between datasets. With respect to dx, dy, and dz no significant differences were found.

Conclusions

- With proper registration, vertical uncertainty in elevation is typically sub-meter, offering a high degree of accuracy.
- No systematic bias is introduced from different sensor models, allowing DSM's to be regarded as if from the same satellite.
- Provided ICESat coregistration parameters are on par with high density LiDAR for most applications, allowing end users to bypass the complex and computationally expensive coregistration process, expediting scientific inquiry.

Funding and Support

polar geospatial center
NCSA
DigitalGlobe
SCHOOL OF EARTH SCIENCES